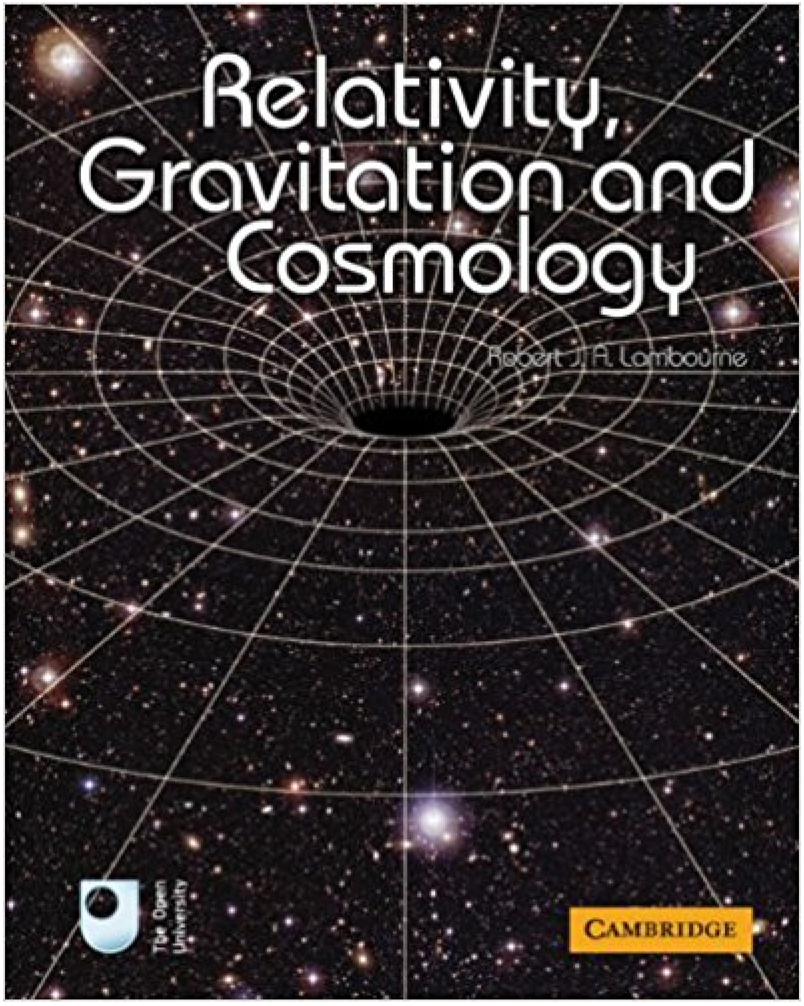
Relativity, Gravitation And Cosmology



Synopsis

Aimed at advanced undergraduates, this self-contained textbook covers the key ideas of special and general relativity together with their applications. The textbook introduces students to basic geometric concepts, such as metrics, connections and curvature, before examining general relativity in more detail. It shows the observational evidence supporting the theory, and the description general relativity provides of black holes and cosmological space-times. The textbook is in full colour, with numerous worked examples and exercises with solutions. Key points and equations are highlighted for easy identification, and each chapter ends with a summary list of important concepts and results. This textbook provides the essential background for an up-to-date discussion of modern observational cosmology. Each chapter builds on the previous one as concepts are developed, making it ideal for self-study. Accompanying resources to this textbook are available at: http://www.cambridge.org/features/astrophysics.

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Customer Reviews

"The author has done a great job of producing a text suitable for upper level undergrads and even first year graduate students. The graphics are very good and I particularly appreciate the concise chapter summaries and the exercises with solutions. Students will love this text. I will definitely use it in my upper division classes." - Professor John Huchra, Harvard University"The presentation of special and general relativity is remarkably clear, with explicit derivations and explanations accompanied by useful and relevant exercises. This text strikes a nice balance between theory and applications and does a commendable job of bringing undergraduates up to speed on a challenging topic. I highly recommend it for a first undergraduate course in general relativity." - Dr Jeremy Darling, University of Colorado"...is an attractive production, with nice clear diagrams, good use of colour, and photographs and thumb-nail sketches of the major contributors to the field. Lambourne's book really scores, however, in its careful, thorough and well thought-out presentation of the subject...The text reads very comfortably and creates a sense that one is being guided by experienced and knowledgeable authors...This is an excellent volume which can be highly recommended for an introductory course on general relativity and I hope will have the effect of increasing understanding of this most beautiful and striking creation of twentieth century physics." - Lewis Ryder, Contemporary Physics, May 2011

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But no, it's true.Ok, folks, let's be candid. Most of you are trying to teach yourselves this stuff. You've made it through quantum mechanics, you get Special Relativity well enough, but General Relativity is an impenetrable barrier. Hartle and Wall are hard, Misner Thorne & Wheeler is terrifying.This is the book you want. The math is clearly presented and the many diagrams and enormously helpful. Each chapter has a summary to prepare you for what follows.Highly recommended.

on the reader but covering the basics in a pedagogically skillful manner. I have not read all of this book, but I have read enough to recommend it to those who want to go beyond popular explanations but are somewhat intimidated by the standard, frequently recommended introductions, e.g., Schutz'sÂ A First Course in General Relativity, Hartle'sÂ Gravity: An Introduction to Einstein's General RelativityÂ or Cheng'sÂ Relativity, Gravitation and Cosmology: A Basic Introduction (Oxford Master Series in Physics).Update 10/02/2012: Just noticed there is a very detailed ToC is available in pdf form from the publisher's website.____I am keeping my less detailed ToC below in case that's more convenient.Here's the Table of Contents:Ch.1 Special Relativity and Spacetime [11 - 44]: 1.1 Basic concepts 1.2 Coordinate transformations 1.3 Consequences of Lorentz transformation 1.4 Minkowski spacetime Interestingly, the discussion of the famous so-called Twin Paradox (no paradox at all), in which one twin stays at home and the other travels away to some distant place and back home only to find his stay-at-home twin older, is analyzed from both the stay-at-home (inertial) twin's viewpoint and the traveling (accelerated) twin's viewpoint. The two calculations agree, as one would expect since special relativity is consistent, and contrary to some misguided impressions, can deal with accelerated reference frames. Many textbooks only look at the problem from the viewpoint of the stay-at-home (inertial) twin. It's really great to see both views explicitly analyzed.Ch.2 Special Relativity and Physical Laws [45-79]: 2.1 Invariants and physical law 2.2. Laws of mechanics 2.3 Laws of electromagnetismCh. 3 Geometry and Curved Spacetime [80-109]: 3.1 Line elements and differential geometry 3.2 Metrics and connections 3.3 Geodesics 3.4 CurvatureCh. 4 General Relativity and Gravitation [110-143]: 4.1 Founding principles of GR 4.2 Basic ingredients (energy-momentum tensor, Einstein tensor) 4.3 Einstein's field equations and geodesic motion Includes the Weak Equivalence principle, Strong Equivalence Principle, Principle of General Covariance.Ch. 5 Schwarzschild Spacetime [144-170]: 5.1 Metric 5.2 Properties 5.3 Coordinates and measurements 5.4 Geodesic motionCh. 6 Black Holes [171 - 203]: 6.1 Introduction 6.2 Non-rotating black holes 6.3 Rotating black holes 6.4 Quantum mechanics and black holes (has brief discussion of Hawking radiation)Ch 7 Testing General Relativity [204-233], including gravitational waves (7.4).Ch 8 Relativistic Cosmology [234 - 276]: 8.1 Basic principles and supporting observations 8.2 Robertson-Walker spacetime 8.3 Friedmann equations and cosmic evolution 8.4 Friedmann-Robertson-Walker models and observations____Features I think particularly helpful for self-study:1. Very clear, reader-friendly exposition, including chapter summaries.2. Full solutions to all problems [pp 279-306].3. Stresses key concepts and overall logic and physical motivation. One will not get lost in a swamp of minutiae (as can happen with Hartle, which is a very fine book too but for many, too ponderous as a first exposure) nor sunk by a barrage of difficult mathematics (as can happen with, e.g. Schutz or D'Inverno, at least for autodidacts with limited background in math or physics). Example: contains a nice, easy to understand discussion of why Newtonian gravity is not Lorentz invariant and later a nice exposition of Newtonian gravity as a field theory, which general relativity must reduce to in the Newtonian limit.4. Very nicely produced with many helpful and attractively produced diagrams. [For me, visually nice diagrams make it easier to understand explanations and also make studying fun. I'm sensitive to how a book looks and have "aging eyes" so appreciate books with a lot of white space and good contrast.]Physics or mathematics majors might feel this book is either too superficial or not rigorous enough in some places but for those who want to ease into general relativity and then move on to harder or more complete books such as Hartle, Schutz or D'Inverno, this is about as good as it gets.Other than this book, in my view the three best books for self-study at an introductory level are:1. Cheng'sÂ Relativity, Gravitation and Cosmology: A Basic Introduction (Oxford Master Series in Physics)2. Hartle'sÂ Gravity: An Introduction to Einstein's General Relativity3. Schutz'sÂ A First Course in General RelativityCheng and Hartle are roughly at the same level of difficulty. I like the succinctness, organization, rigor and overall clarity of Cheng. It also includes answers to selected problems. Hartle, on the other hand, is wordier ("physics first'!) and has no solutions to exercises. I have used Hartle mostly as a reference and found it very helpful on many topics. Schutz is significantly more demanding, mainly because the mathematics is more abstract, but it's generally clearly written. The 1st edition of Schutz contains answers or hints to some problems but the newer edition does not. Overall, then, for the next step up from Lambourne, I think Cheng is the best choice.

I bought this book as a teaser before attending the relativity course with Open University UK, as this book is material for the course. I trusted this book would help me learn relativity in advance of the course, and I was not wrong. As a matter of fact, all the course material from OU proved comprehensive; without these courses I would have not been able to understand quantum mechanics, differential equations, simple relativity and, until now - some general relativity (as I did not finish this book yet).Most probably you will not be able to successfully get through this material unless you already have advanced mathematical knowledge at undergraduate level (differential equations, matrices, vector spaces etc...).What I appreciate very much about this book is that it introduces four vectors and four tensors in a "gentle" manner, your understanding of these notions comes up naturally while reading the book and learning the physics behind the pages, being less worried about the math. I am currently reading the end of the third chapter, learning about space curvature and the Reimann tensor. So far so good!

I've always had an interest in cosmology. I remember as a college student in the 1960's being acquainted with the two competing theories: the Steady State Theory of Continuous Creation (championed by Fred Hoyle) and the Big Bang Theory (championed by George Gamow). At that time I remember being excited by the data coming in from the Cosmic Background Radiation whose 3 degree Kelvin black-body radiation supported the Big Bang. Astrophysics has been my passion since!A few months ago I worked thru Andrew Liddle's excellent little (no pun intended) book entitled AN INTRODUCTION TO MODERN COSMOLOGY (3RD ED). As a follow-up I took on this book, RELATIVITY, GRAVITATION, AND COSMOLOGY which was recommended as a next step by Liddle's book. And an excellent book it is!Unlike some other technical books I've worked thru, I ran across no errors in anything in this book! The material is presented logically interspersed with "exercises" for the reader to try, to check for your own understanding. I tried every exercise and was able to solve almost all of them on my own. All of the answers are given in the back of the book along with their solutions if you need to see them!The first 2 chapters review Special Relativity thru the concept of Four-Vectors.Ch 3 introduces the math of 3 dimensional Riemann curved space giving line elements and matrices. It also introduces the ideas of parallel transport, connection coefficients, geodesic equations, the Riemann Tensor, and the curvature of spacetime. I was not acquainted with this type of thing before so it was slow-going. If you like working with indices you'll have a great time with this chapter!Ch 4 deals with introductory principles of General Relativity and gravitation. Covariant differentiation, the energy-momentum tensor relating to regions of dust, ideal fluids, radiation along with the Einstein Tensor and Einstein Field Equations are presented. Dark energy: pressure and density are also described.Ch 5 presents Schwarzchild Spacetime which deals with the mass causing gravitation as a simple, spherical, non-rotating symmetrical body. The Schwarzchild metric is derived and properties of Schwarzschild spacetime are discussed.Ch 6 deals with Black Holes. First the non-rotating kind, then the rotating kind. Parts of this chapter I found difficult. Some of the items such as the line element for the rotating black hole are so complicated, the author states the derivation is not shown in the book since it is too complicated.I found Ch 7 dealing with Testing General Relativity very interesting. The book does not show most of the derivations of key formulas again, since they are too complex for this book, but formulas are given along with examples for: 1. The precession of the perihelion of Mercury. 2. The deflection of light passing a massive body like the sun. 3. Gravitational redshift and time delay. 4. Geodesic precession. 5. Gravitational lensing.Gravitational waves are discussed although they were not yet discovered as of 2010 when this book was written. Today (2016) they have been, so the book needs an update.Ch 8 deals with Relativistic Cosmology. It gets into the expanding universe, the Robertson-Walker Metric, Hubble's law, curvature of the universe, the Friedmann and Fluid equations. Solutions to the Friedmann equations are given with cosmological models to work thru.In conclusion, RELATIVITY, GRAVITATION, AND COSMOLOGY by Lanbourne was an excellent book for me. I enjoyed it. Some of the math was a bit of a stretch for me but I felt I was able to comprehend most of it. My plans are now to work thru a book recommended as a follow-up entitled OBSERVATIONAL COSMOLOGY from the same publisher.

Well written for beginner to intermediate level.